WO 2004/008013

10/527363 Rec'd PCT/PTO 10 MAR 2005

### FLEXIBLE FLUID LINE CONNECTOR ASSEMBLY

[0001] This application claims the benefit of U.S. Provisional Application No. 60/395,823, filed on July 15, 2002, which is hereby incorporated herein by reference in its entirety.

## **Background of the Invention**

[0002] This invention relates to the art of fluid line connector assemblies and, more particularly, to thin-walled, flexible fluid line connector assemblies for use in low-pressure applications.

[0003] Thin-walled, flexible fluid line connector assemblies have been provided heretofore and generally include a length of thin-walled, corrugated, flexible tubing having opposing non-corrugated tubing ends, a flare nut retained on each tubing end and a flare fitting cooperable with each flare nut to form a fluid-tight seal between the flare fitting, tubing end and flare nut. The tubing ends commonly include a generally cylindrical journal portion and a radially outwardly extending flare portion. The flare nuts are retained on the non-corrugated tubing ends by the flare portion, which is deformed radially outwardly after assembly with a flare nut to engage the flare nut and thereby prevent removal thereof from the length of tubing. To form the fluid-tight seal with the flexible tubing, a flare fitting is threadably engaged into each of the flare nuts. The flare fitting includes a frustoconical leading surface which compressively engages the flare portion of the tubing end. As the flare fitting and flare nut are threadably tightened together, the frustoconical leading surface of the flare fitting displaces the flare portion of the flexible tubing against an interior surface of the flare nut. This

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displacement causes the flare portion of the tubing to be compressively engaged between the flare fitting and flare nut, and causes a metal-to-metal seal to form between the tubing, the flare fitting and the flare nut such that the assembly becomes fluid tight.

[0004] A disadvantage of connector assemblies of the foregoing nature is that tightening the flare nut and flare fitting together to form the metal-to-metal seal with the flexible tubing causes the flare fitting, flare nut and flexible tubing to become rotatably fixed relative to one another. As such, the flare fitting and flare nut are not able to rotate relative to the thin-walled, flexible tubing. As a result, the flexible tubing can become torsionally stressed during the installation of the connector assembly, such as installation between a gas supply line and an appliance.

[0005] Additionally, such connector assemblies undesirably include an additional threaded connection or joint which can be the source of leaks. The flare fitting and flare nut are threadably connected together to forming a metal-to-metal seal with the flexible tubing. Opposite the threaded portion of the flare fitting that engages the flare nut is a male or female pipe thread which then must threadably engage a corresponding thread, such as on a gas supply line or appliance, for example. As such, two threaded connections are necessary at each end of the gas line connector assembly to install the same in a typical manner. Furthermore, three or more threaded connections may be necessary if additional connecting devices, such as quick-connect fittings or multiplane swivel fittings, are installed. It will be appreciated that the more threaded connections that are used, the greater the opportunity for leaks to develop.

[0006] Also, connections between end fittings are generally not seamless. Rather, the edges on the fittings and the axial gaps therebetween, which open radially outwardly from the fluid passages that extend through the fittings, create annular

cavities that can disrupt the flow of fluid through the passage extending through the fittings. Furthermore, the gaps and edges cause resistance to fluid flow between the passages. Therefore, each additional fitting added to an end of the connector assembly causes an increase in the resistance to fluid flow through the completed assembly, due at least in part to the attendant gap and edges from the additional fitting or fittings.

[0007] Furthermore, the flare fitting is an additional component that must be inventoried, shipped and installed. In most cases, two flare fittings are used for each assembly. As such, this undesirably adds significant manufacturing, inventory and shipping costs to the finished assembly.

#### **Brief Summary of the Invention**

[0008] In accordance with the present invention, a thin-walled, flexible fluid line connector assembly is provided that avoids or minimizes the problems and difficulties encountered in connection with connector assemblies of the foregoing nature while promoting an increase in performance and reliability, and maintaining a desired simplicity of structure, economy of manufacture and ease of installation.

[0009] More particularly in this respect, a fluid line connector assembly is provided that includes a length of flexible tubing having a tubing end. An end fitting is rotatably supported on the tubing end, and a sealing member is compressively positioned between the tubing end and the end fitting. A retainer extends from the tubing end and engages the end fitting preventing the axial removal of the same from the tubing end.

[0010] Additionally, a fluid line connector assembly is provided that includes a length of flexible tubing having a generally cylindrical tubing end. An end fitting is also provided that has an inside wall at least partially defining a passage through the end fitting. The passage is adapted to receive the tubing end such that the end fitting is

rotatably supported on the tubing end. A sealing member is sealingly disposed between the tubing end and the end fitting. A retainer extends from the tubing end radially outwardly beyond the inside wall of the end fitting such that the end fitting is axially retained on the tubing end.

[0011] A method of assembling a fluid connector assembly is also provided and includes the steps of providing a length of flexible tubing having a tubing end, providing an end fitting having an inside wall at least partially forming a passage through the end fitting, and providing a sealing member. Another step includes installing the sealing member on one of the tubing end and the end fitting. Still another step includes installing the end fitting on the tubing end such that the passage receives the tubing end and the sealing member is compressively positioned between the tubing end and the end fitting. Still another step includes forming a retainer on the tubing end to axially retain the end fitting thereon.

## **Brief Description of the Drawings**

- [0012] FIGURE I is a cross-sectional view of a conventional connector assembly shown partly assembled.
- [0013] FIGURE 2 is a cross-sectional view of the conventional assembly of FIGURE 1 shown fully assembled.
- [0014] FIGURE 3 is a partial cross-sectional view of a fluid line connector assembly in accordance with the present invention.
- [0015] FIGURE 4 is an enlarged view, shown partially in section, of a portion of the fluid line connector assembly in FIGURE 3.
- [0016] FIGURE 5 is a partial cross-sectional view of the fluid line connector assembly in FIGURE 3 shown with quick-connect end fittings.

- [0017] FIGURE 6 is a partial cross-sectional view of the fluid line connector assembly in FIGURE 3 shown with multi-plane end fittings.
- [0018] FIGURE 7 is a partial cross-sectional view of an alternate embodiment of a fluid line connector assembly in accordance with the present invention.
- [0019] FIGURE 8 is an enlarged view, shown partially in section, of a portion of the fluid line connector assembly shown in FIGURE 7.
- [0020] FIGURE 9 is a partial cross-sectional view of another alternate embodiment of a fluid line connector assembly in accordance with the present invention.
- [0021] FIGURE 10 is an enlarged view, shown partially in section, of a portion of the fluid line connector assembly shown in FIGURE 9.
- [0022] FIGURE 11 is a partial cross-sectional view of still another alternate embodiment of a fluid line connector assembly in accordance with the present invention.
- [0023] FIGURE 12 is an enlarged view, shown partially in section, of a portion of the fluid line connector assembly shown in FIGURE 11.
- [0024] FIGURE 13 is a partial cross-section view of yet another alternate embodiment of a fluid line connector assembly in accordance with the present invention.
- [0025] FIGURE 14 is an enlarged view, shown partially in section, of a portion of the fluid line connector assembly shown in FIGURE 13.
- [0026] FIGURE 15 is a partial cross-sectional view of a further alternate embodiment of a fluid line connector assembly in accordance with the present invention.
- [0027] FIGURE 16 is an enlarged view, shown partially in section, of a portion of the fluid line connector assembly shown in FIGURE 15.

#### **Detailed Description of the Invention**

[0028] It will be appreciated that FIGURES 1 and 2 respectively illustrate a conventional fluid line connector assembly for connection between a fluid transmission line and an appliance, such as a gas supply line and a gas stove, for example. Such fluid line connector assemblies are generally known by those skilled in the art, and the following discussion of FIGURES 1 and 2 is merely provided to establish background environment and terminology for further discussion of the preferred embodiments of the present invention.

[0029] FIGURE 1 illustrates a conventional fluid line connector assembly 10 that includes a length of thin-walled, flexible tubing 20, a flare nut 40 and a flare fitting 60. Length of tubing 20 has two opposing tubing ends 22, only one of which is shown in FIGURES 1 and 2. Tubing end 22 terminates at a tubing end edge 24 and includes a journal portion 26 and a flare portion 28. Length of thin-walled, flexible tubing 20 has a plurality of helically extending tubing corrugations 30 and is formed from metal, typically stainless steel.

[0030] Flare nut 40 is retained on at tubing end 22 of tubing 20. The flare nut has a threaded end 42 and a strain-relief end 44. A journal passage 46 extends through flare nut 40 and is cooperable with journal portion 26 of tubing end 22 such that the flare nut is freely rotatable about a central axis CL of assembly 10 as shown by arrows A. Extending toward threaded end 42 from journal passage 46 is flare seating surface 48, which extends radially outwardly from the journal passage in a frustoconical manner. Female fitting threads 50 extend inwardly from threaded end 42 toward flare seating surface 48. The female fitting threads are generally coaxial with journal passage 46. Opposite female fitting threads 50 at strain-relief end 44 is an axially-extending annular recess 54 that extends from the strain-relief end toward the threaded end and is

adapted to receive at least a portion of one or more of corrugations 30. Wrench flats 52 extend along at least a portion of the exterior of flare nut 40. Flare portion 28 of tubing end 22 extends radially outwardly from journal portion 26 adjacent flare seating surface 48 of flare nut 40. As indicated by arrow A, in the disassembled condition, flexible tubing 20 and flare nut 40 are rotatable relative to one another.

[0031] Flare fitting 60 is shown in FIGURE 1 disassembled from tubing 20 and flare nut 40. The flare fitting has a fitting end 62 and a connection end 68. The fitting end has male fitting threads 64 adjacent a flare-engaging surface 66. The connection end includes connection threads 70. Positioned between the fitting end and the connection end of flare fitting 60 are wrench flats 72. A fluid passage 74 extends centrally through flare fitting 60.

[0032] FIGURE 2 shows male fitting thread 64 of flare fitting 60 engaged with female fitting threads 50 of flare nut 40. As flare fitting 60 is threadably rotated into flare nut 40, flare-engaging surface 66 of the flare fitting advances toward flare portion 28 of flexible tubing 20. Ultimately, flare-engaging surface 66 contacts flare portion 28, which is thereby forced against flare seating surface 48 effecting metal-to-metal contact between the three components. Once such contact has been made, further rotation of the flare fitting into the flare nut causes a metal-to-metal seal to form between flare-engaging surface 66 of the flare fitting, flare portion 28 of the flexible tubing and flare seating surface 48 of the flare nut. This metal-to-metal seal is suitable for forming a fluid-tight passage through connector assembly 10. It will be appreciated, however, that this same metal-to-metal contact between the three components prevents rotation of these components relative to one another. As such, it will be appreciated that the entire connector assembly 10 must be rotated to threadably engage connection threads 70 to a fluid transmission line or appliance (not shown).

[0033] Referring now in greater detail to FIGURES 3-16, wherein the showings are for the purposes of illustrating preferred embodiments of the invention only, and not for the purpose of limiting the invention, FIGURES 3 and 4 illustrate a fluid line connector assembly 100 that includes a length of thin-walled, flexible tubing 120 with opposing ends 122, and an end fitting 140 retained on each of the tubing ends. It will be appreciated that one or more of the embodiments disclosed herein include two opposing tubing ends and an end fitting supported on each end. However, it will also be appreciated that the use of an end fitting on both ends of the tubing is optional and that other embodiments are contemplated that have an end fitting on only one end. Such embodiments of fluid line connector assemblies are fully intended to fall within the scope of the present invention. For example, one alternate embodiment could include a length of flexible tubing having an end fitting supported on one end of the tubing in accordance with the present invention. The other end of the tubing could be brazed onto an appliance or supply line adapter forming a generally fixed connection thereto.

[0034] Returning again to FIGURES 3 and 4, length of thin-walled, flexible tubing 120 extends between tubing edges 124. Tubing ends 122 adjacent edges 124 are non-corrugated and generally cylindrical, and the tubing ends include a journal portion 126 and a flare portion 128. Tubing corrugations 130 extend helically along the length of flexible tubing between tubing ends 122.

[0035] As can be better seen in FIGURE 4, end fittings 140 are supported and retained on tubing ends 122 such that the end fittings remain rotatable on the flexible tubing while still enabling the formation of a fluid-tight seal therewith. It will be appreciated that end fittings 140 shown in FIGURES 3-6 are rotatable, as indicated by arrows RO, relative to tubing ends 122 about a central axis AX. End fittings 140 have

a threaded end 142 and a strain-relief end 144. Wrench flats 152 are positioned along the exterior of the end fitting between the threaded and strain-relief ends.

[0036] Extending centrally through the end fitting is a journal passage 146, which is cooperable with journal portion 126 of tubing end 122 of flexible tubing 120. Two optional seal receiving grooves 156 are positioned along journal passage 146 and extend radially outwardly into end fitting 140. Seal members, such as o-rings 180, are compressively positioned between one or more walls of each groove 156 and journal portion 126 of tubing ends 122. A flare-engaging surface 148 extends radially outwardly from journal passage 146 in a generally frustoconical manner. Flare-engaging surface 148 is cooperable with flare portion 128 of the tubing end such that end fitting 120 is axially retained on the tubing end. An optional annular recess 154 extends into end fitting 140 from strain-relief end 144 such that at least a portion of one or more tubing corrugations 130 is received within the annular recess. Opposite the strain-relief end, male connection threads 158 extend along end fitting 140 at threaded end 142. Threads 158 are shown in FIGURES 3 and 4 as tapered pipe threads. However, it will be appreciated that threads 158 may be of any suitable form or pitch.

[0037] The end fittings are shown with two seal grooves and assembled with a seal member in each groove. However, only one seal member or more than two seal members, each having a separate seal groove, may be used for each end fitting. Additionally, other configurations utilizing seal members without grooves can be used. As such, it should be appreciated that the present invention is not intended to be limited to arrangements having two seal members and two seal grooves.

[0038] In assembling the components of fluid line connector assembly 100, a length of thin-walled, flexible tubing 120 is provided. The flexible tubing extends between

tubing edges 124 and has helical corrugations 130 along its length with non-corrugated and generally cylindrical tubing ends 122 adjacent the tubing edges. Initially, tubing ends 122 preferably include only a generally cylindrical journal portion 126. That is, flare portion 128 is not initially formed on tubing end 122. End fitting 140 and seal members, such as o-rings 180, are assembled onto journal portion 126 of the tubing ends. Preferably, each o-ring 180 is inserted and captured within a seal-receiving groove 156. Journal passage 146 of the end fitting and o-rings 180 slidably engage journal portion 126 of tubing ends 122 and are axially advanced along the journal portion until annular recess 154 engages at least a portion of tubing corrugations 130. Flare portion 128 is then formed adjacent tubing edge 124 such that the flare portion extends radially outwardly beyond the wall that forms passage 146. Preferably, flare portion 128 is cooperable with flare-engaging surface 148 of end fitting 140 to retain the end fitting on tubing end 122. Due to the positioning of the seal members between the end fitting and the journal portion of the tubing end, a fluid-tight seal is formed therebetween. The end fitting is axially captured between the flare portion and the corrugations of the flexible tubing. However, the end fitting remains freely rotatable, substantially eliminating the possibility of torque-induced stress during installation. It will be appreciated that in known fluid line connector assemblies the flare portion of the tubing end was necessary to form the metal-to-metal seal with the flare fitting and flare nut to form a fluid-tight connection. As such, the shape, form and dimensional tolerances of the flare portion were important to the formation of a fluidtight seal. In the assembly of the present invention the flare portion of the tubing end is primarily used to retard pullout of the flexible tubing from the end fitting. While fluid line connector assemblies are often designed and manufactured to withstand a specified amount of pullout force, the flare portion of the present invention may take any suitable form or shape to provide such desired amount of resistance to pullout. In FIGURES 3-8, the flare portion is shown as extending outwardly at approximately 45°. However, it will be appreciated that other suitable forms may be used. For example, the flare portion may be rolled or flared outwardly at a 90° from the central axis AX. Alternately, the flare portion can be formed in a circumferentially and/or radially discontinuous manner, for example.

[0040] FIGURES 5 and 6 illustrate fluid line connector assembly 100, as described hereinbefore, prior to assembly with known connecting devices. FIGURE 5 shows fluid line connector assembly 100 having a length of thin-walled, flexible tubing 120 with end fittings 140 supported on opposing ends thereof, and two seal members, such as o-rings 180, positioned between each associated end fitting and tubing end. Shown adjacent one end fitting 140 is a quick connect fitting QC having a female portion QF and a male portion QM. Female portion QF is adapted to receive, retain and form a fluid-tight seal with male portion QM in the manner well known in the art. Female portion QF includes an end surface ES from which female threads (not shown) extend axially into the female portion. The threads (not shown) are suitable for threadably engaging male threads 158 of end fitting 140 to form a fluid-tight connection. Male portion QM likewise includes an end surface ES from which female threads (not shown) extend axially into the fitting portion. It will be appreciated that such threads in male portion QM are suitable for forming a fluid-tight connection with a fluid transmission line or appliance, such as a gas supply line or gas stove (not shown), for example.

[0041] FIGURE 6 illustrates a fluid line connector assembly 100 having flexible tubing 120, and end fitting 140 retained at each end of the flexible tubing, and two seal members, such as o-rings 180, positioned between the end fitting and the tubing ends.

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The fluid line connector assembly is shown prior to assembly with a multi-plane swivel connector MP adjacent each end fitting. Such multi-plane swivel connectors are generally known to those skilled in the art and include two fitting portions FA and FB which are pivotally connected in a fluid-tight manner to permit rotation about an axis AM. Fitting portion FA includes an end surface ES' from which female threads (not shown) extend axially into the fitting portion. It will be appreciated that such threads are suitable for forming a fluid-tight connection with male threads 158 of end fitting 140. The second fitting portion FB includes a rotatable threaded end RT suitable for forming a fluid-tight connection with a fluid transmission line or appliance, such as a gas supply line or gas water heater (not shown), for example. It will be appreciated that various other connector devices can be used in conjunction with the end fittings of fluid line connector assembly 100, and that the connector devices shown and described hereinbefore may be used in other combinations and in combination with other similar type fluid connector devices.

[0042] FIGURES 7 and 8 illustrate an alternate embodiment of a fluid line connector assembly in accordance with the present invention. As shown in FIGURE 7, fluid line connector assembly 200 includes a length of thin-walled, flexible tubing 220 extending between tubing edges 224 and having a non-corrugated and generally cylindrical tubing end 222 inwardly adjacent the each tubing edge. Tubing ends 222 include a journal portion 226 and a flare portion 228 extending radially outwardly from the journal portion. The length of flexible tubing 220 has helical corrugations 230 extending therealong between ends 222.

[0043] An end fitting 240 is rotatably supported on each tubing end 222 and has a threaded end 242 and a strain-relief end 244. Arrows RO indicate that each end fitting 240 is rotatable relative to an associated tubing end generally about central axis AX<sup>2</sup>.

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An annular recess 254 suitable for receiving corrugations 230 extends axially into end fitting 240 from strain-relief end 244. A journal passage 246 extends centrally through the end fitting and is cooperable with journal portion 226 of flexible tubing 220. Extending radially outwardly from journal passage 246 is a flare-engaging surface 248. Flare portion 228 of tubing end 222 is positioned adjacent flare-engaging surface 248 and is cooperable therewith. Seal receiving grooves 256 are optionally provided and are positioned along journal passage 246 and extend radially into end fitting 240. A seal member, such as an o-ring 280, is captured within each of grooves 256 and is compressively positioned between one of the walls of groove 256 and journal portion 226 of tubing end 222. Positioned between threaded end 242 and strain-relief end 244 are wrench flats 252. Threaded end 242 includes male connection threads 258 and female connection threads 259 extending therealong. Both male connection threads 258 and female connection threads 259 are shown in FIGURES 7 and 8 as being tapered pipe threads. However, it will be appreciated that other thread forms and pitches may be used to form a fluid-tight connection between these threads and a fluid transmission line or appliance (not shown).

[0044] It will be further appreciated that the embodiment illustrated in FIGURES 7 and 8 would be assembled in a manner substantially similar to that described for the connector assembly shown in FIGURES 3-6. As such, the steps setting out the method of assembly will not be further discussed. Furthermore, it will be appreciated that flaring of thin-walled tubing and the equipment therefore, such as flaring devices, are generally known by those skilled in the art.

[0045] FIGURES 9-12 illustrate another embodiment of a fluid line connector assembly in accordance with the present invention. As shown in FIGURE 9, fluid line connector assembly 300 includes a length of thin-walled, flexible tubing 320 extending

between tubing edges 324 and having a non-corrugated and generally cylindrical tubing end 322 inwardly adjacent each tubing edge. The length of flexible tubing 320 has helical corrugations 330 extending therealong between tubing ends 322.

[0046] An end fitting 340 is rotatably supported on each tubing end 322 and has a threaded end 342 and a strain-relief end 344. Arrows RO indicate that each end fitting 340 is rotatable relative to an associated tubing end generally about central axis AX. An annular recess 354 suitable for receiving at least a portion of one or more corrugations 330 extends axially into end fitting 340 from strain relief end 344. A journal passage 346 extends centrally through the end fitting and is cooperable with tubing end 322.

[0047] As can be better seen in FIGURE 10, a retaining groove 370 is provided in each tubing end 322. A corresponding retaining groove 372 is provided in end fitting 340, which is received on tubing end 322 such that grooves 370 and 372 are axially adjacent and suitable for each at least partially receiving a portion of a retaining ring 374. A tapered surface 376 is provided adjacent annular recess 354 to facilitate assembly of the end fitting and retaining ring onto the tubing end.

[0048] Seal receiving grooves 356 extend radially outwardly from journal passage 346 and are each suitable for receiving a seal member, such as an o-ring 380. Each seal member is captured within a different one of grooves 356 and is compressively positioned between one of the walls of the groove and tubing end 322. Positioned between threaded end 342 and strain relief end 344 are wrench flats 352. Threaded end 342 includes male connection threads 358 and female connection threads 359 extending therealong. Both male connection threads 358 and female connection threads 359 are shown in FIGURES 9 and 10 as being tapered pipe threads. However, it will be appreciated that other thread forms and pitches may be used to form a fluid-

tight connection between these threads and a fluid transmission line or appliance (not shown).

[0049] FIGURES 11 and 12 illustrate a further embodiment of a fluid line connector assembly in accordance with the present invention. It will be appreciated that the embodiment illustrated in FIGURES 11 and 12 is substantially similar to the embodiment illustrated in FIGURES 9 and 10. However, fluid line connector assembly 300' includes end fittings 340' in FIGURES 11 and 12, which are shown with male connection threads 358' at threaded end 342', and which do not include female connection threads 359 as shown in FIGURES 9 and 10. Importantly, end fittings 340' remain rotatable relative to the length of flexible tubing as indicated by arrows RO. Male connection threads 358' are shown in FIGURES 11 and 12 as being tapered pipe threads. However, it will be appreciated that other thread forms and pitches may be used to form a fluid-tight connection between these threads and a fluid transmission line or appliance (not shown). Additionally, it will be appreciated that an end fitting having female threads and not including male threads is also envisioned.

[0050] Still another embodiment of the present invention is illustrated in FIGURES

[0050] Still another embodiment of the present invention is illustrated in FIGURES 13 and 14, which show a fluid line connector assembly 400 that includes a length of thin-walled, flexible tubing 420 extending between tubing edges 424 and having a non-corrugated and generally cylindrical tubing end 422 inwardly adjacent each tubing edge. The length of flexible tubing 420 has helical corrugations 430 extending therealong between ends 422.

[0051] An end fitting 440 is rotatably supported on each tubing end 422 and has a threaded end 442 and a strain-relief end 444. Arrows RO indicate that each end fitting 440 is rotatable relative to an associated tubing end generally about central axis AX. An annular recess 454 suitable for receiving corrugations 430 extends axially into end

fitting 440 from strain-relief end 444. A journal passage 446 extends centrally through the end fitting and is cooperable with tubing end 422.

[0052] A retaining groove 472 is provided in end fitting 440. The end fitting is positioned on tubing end 422 such that a protrusion 478 extending radially outwardly from tubing end 422 engages retaining groove 472 and axially retains end fitting 440 on the tubing end. Seal receiving grooves 456 are positioned along journal passage 446 and extend radially into fitting 440. A seal member, such as an o-ring 480, is captured within each of grooves 456 and is compressively positioned between one of the walls of each groove 456 and tubing end 422. Positioned between threaded end 442 and strain-relief end 444 are wrench flats 452. Threaded end 442 includes male connection threads 458 and female connection threads 459 extending therealong. Both male connections threads 458 and female connection threads 459 are shown in FIGURES 13 and 14 as being tapered pipe threads. However, it will be appreciated that other thread forms and pitches may be used to form a fluid-tight connection between these threads and a fluid transmission line or appliance (not shown).

[0053] FIGURES 15 and 16 illustrate yet another embodiment of the present invention. It will be appreciated that the embodiment illustrated in FIGURES 15 and 16 is substantially similar to the embodiment illustrated in FIGURES 13 and 14. However, fluid line connector assembly 400' includes end fittings 440' in FIGURES 15 and 16, which are shown with male connection threads 458' at threaded end 442', and which do not include female connection threads 459 as shown in FIGURES 13 and 14. Importantly, end fittings 340' remain rotatable relative to the length of flexible tubing as indicated by arrows RO. Male connection threads 458' are shown in FIGURES 15 and 16 as being tapered pipe threads. However, it will be appreciated that other thread forms and pitches may be used to form a fluid-tight connection

between these threads and a fluid transmission line or appliance (not shown).

Additionally, it will be appreciated that an end fitting having female threads and not including male threads is also envisioned.

[0054] Assembly of connector assemblies 400 and 400' generally includes steps substantially similar to those discussed hereinbefore with regard to connector assemblies 100 and 200 and, as such, will not be reiterated in detail. However, in assembling connector assemblies 400 and 400', projection 478 is preferably formed in place of flare portion 128 of connector assembly 100. As with flare portion 128, projection 478 can be formed in any suitable shape or configuration extending radially outwardly into groove 472 to axially retain the end fitting on the tubing end.

[0055] While the invention has been described with reference to the preferred embodiments and considerable emphasis has been placed herein on the structures and structural interrelationships between the component parts of the embodiments disclosed, it will be appreciated that other embodiments of the invention can be made and that many changes can be made in the embodiments illustrated and described without departing from the principles of the invention. Obviously, modifications and alterations will occur to others upon reading and understanding the preceding detailed description. For example, the generally cylindrical portions of the tubing ends could alternately be faceted or include flats and/or other shapes or forms. As another example, an alternate form or configuration of connection could be used instead of the male and/or female threads on the various end fittings. Accordingly, it is to be distinctly understood that the foregoing descriptive matter is to be interpreted merely as illustrative of the present invention and not as a limitation. As such, it is intended that the invention be construed as including all such modifications and alterations insofar as they come within the scope of the appended claims or the equivalent thereof.

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